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(54) CHARGED BEAM CROSS SECTION MACHINING/OBSERVING DEVICE



(57)Abstract:

PURPOSE: To immediately find a fine foreign object and an abnormal shape by displaying a SIM image on positioning or cross section machining by an ion beam and a SEM image on cross section observation by an electron beam in conjunction with beam switching.

CONSTITUTION: An ion beam 1 emitted from an ion source (Ga) 31 and accelerated and focused by an ion optical system 3 is scanned on a sample 2 by an XY deflecting electrode 38, a beam blanking electrode 40 and a sample stage 4. Secondary electrons 5 are detected by a detector 6, and a SIM image is displayed on a CRT 20. An electron beam 11 emitted from an electron source 10 and accelerated and focused by an electronic optical system 41 is scanned on the sample 2 by an XY deflecting coil 18. Secondary electrons 5 generated from the sample 2 are detected by the detector 6, and a SEM image is displayed on the CRT 20. The SIM image and the SEM image are selectively displayed on the CRT 20 via SIM and SEM amplifiers 18, 19 and a beam switching unit 17.

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CLAIMS

(57) [Claim(s)]

[Claim 1] Have the following and said beam switcher and said secondary electron control system are interlocked, At the same time it changes said focused ion beam and an electron beam by said beam switcher, Charged beam cross section processing and a viewing device which setting out of said secondary electron control system changes, and is characterized by carrying out image display of a specimen surface picture by said focused ion beam, and the cross section image by said electron beam to said image display device.

Focused ion beam illuminating system which makes a specimen surface scan a focused ion beam.

An electron beam irradiation system which makes said specimen surface scan an electron beam.

A sample stage to which said sample is moved.

A secondary electron detector which catches a secondary electron emitted from said specimen surface at the time of said focused ion beam or said electron beam exposure, In charged beam cross section processing and a viewing device which comprises a beam switcher which changes a beam of an image display device which displays an output of said secondary electron detector as a picture, and a focused ion beam from said focused ion beam illuminating system and an electron beam from said electron beam irradiation system, It is a secondary electron control system which can be set as optimal state about signal processing which arranges the illumination axis of each other at an angle narrower than 90 degrees, and is outputted from said secondary electron detector for every beam of said focused ion beam and said electron beam in said focused ion beam illuminating system and said electron beam irradiation system.

[Claim 2]Charged beam cross section processing and the viewing device according to claim 1, wherein it interlocks and said signal processing is changed at the same time it is made with a preamplifier for SIM and a preamplifier for SEM which are set in front of a main amplifier and an ion beam and an electron beam are changed by said beam switcher.

[Claim 3]a photo-multiplier high voltage power supply in said secondary electron detector — an object for SIM, and an object for SEM — charged beam cross section processing and the viewing device according to claim 1 or 2 interlocking and changing at the same time it makes it separate and an ion beam and an electron beam are changed by said beam switcher.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[Industrial Application]

In this invention, while having accomplished progress with rapid densification of an integrated circuit and minuteness making, it is going to use for the process evaluation for obtaining the device of high performance and high-reliability.

Therefore, it is related with semiconductor manufacturing process evaluation, and the charged beam cross section processing and the viewing device for conducting failure analysis.

[Summary of the Invention]

The scanning ion microscope (following SIM) function which this invention detects the

secondary electron emitted by ion beam irradiation from a sample, and carries out image display. With the charged beam device which has a scanning electron microscope (following SEM) function which detects and carries out image display of the secondary electron emitted by electron beam exposure from a sample. By ion beam irradiation, in order to perform cross section processing and to perform section observation by the SEM image according this section to an electron beam exposure by sputter etching processing and metal membrane attachment processing by material gas spraying and ion beam irradiation, Superposition illuminating system is arranged for the same point in a sample, it has a control system which can be set up for every beam, beam change machine linkage of the secondary electron signal processing is carried out, and ** also provides a good secondary electron image for the SEM image according the SEM image by ion beam irradiation to an electron beam exposure in an instant.

[Description of the Prior Art]

The device which had densification minuteness making multilevel interconnection and the three-dimensional structure in the integrated circuit is developed, and a manufacturing process is becoming increasingly complicated. SEM was mainly conventionally used for these distance evaluations. And section observation performed cross section processing by mechanical cutting, polish, etching, etc., and was carrying out section observation of the sample by SEM. However, it is difficult for this method to take out the accuracy of processing position ****, and, moreover, there are problems, like floor to floor time is long 1 sectional view by one sample, and when it was an integrated circuit, it came to observe two or more sectional views of a place to a law. Then, the ion beam cross section processing viewing device was developed. (Japan Society for the Promotion of Science - a charged particle beam — the [application / 132nd time / 109th / committee] research sample to industry, and 1989.12 "focused ion beam device SMI-8300 for section observation") this device. The ion by which it was generated from the ion source serves as a focused ion beam, and it is irradiated with it on a sample by the ion optics system containing two steps of electrostatic lenses. The focused ion beam can scan the arbitrary places of a sample with a sample stage and XY deflecting electrode. The positioning of the purpose processing site can do the localization by detecting the secondary electron of ion beam excitation by secondary electron detection, and displaying a secondary electron image on CRT for observation. Narrow the scan size of a focused ion beam and material gas is sprayed to a specimen surface by an organometallic compound gas gun here, the ion beam CVD (chemical gaseous phase deposition) — after performing metal membrane attachment by law, a scan size is restricted to the perforation position of a section to observe, and ion-beam-etching processing performs partial cross section processing. They are the ion beam cross section processing and the viewing device which makes a sample incline by 5 axis stages, displays a secondary electron image on CRT for observation, and

performs section observation so that the bore diameter of a movable diaphragm may be made small after cross section processing, a beam current may be reduced and said cross section part can be seen.

[Problem(s) to be Solved by the Invention]

The cross section processing by the ion beam of said charged beam cross section processing and viewing device and the section observation by an electron beam were switched with the beam change machine, caught the secondary electron emitted from a sample at the time of each beam irradiation with the secondary electron detector, and showed the output signal to the image display device. However, since the amount of secondary electrons emitted from the sample at the time of the cross section processing by an ion beam differed from the amount of secondary electrons emitted from the sample at the time of the section observation by an electron beam considerably, the change of a clear SIM image and a SEM image of it was not completed.

[The means for solving a technical problem]

SIM images, such as position appearance interception side machining in order to solve said problem, it has a secondary electron detector control system which can set up the conte lath and luminosity of a secondary electron image for every beam, and make it a beam change machine interlocked with, and according to an ion beam, They are the charged beam cross section processing and the viewing device being able to display vividly SEM images, such as section observation by an electron beam, and SEM images, such as section observation by an electron beam, on a beam change and linkage to an image display device.

[Function]

A sample is put on an angle vertical to an ion beam axis, or vertically near, processing position **** by a SIM image is performed, by metal membrane attachment processing by material gas spraying and ion beam irradiation which are organic compounds, a hole is made by sputter etching processing by ion beam irradiation, and cross section processing is performed. Next, it switches to an electron beam exposure from ion beam irradiation with a beam change machine, and SEM image observation by electron beam exposure is performed from an oblique position. Usually, in order to perform cross section processing and section observation operation repeatedly several times, like this invention. When an ion beam and an electron beam are provided with the secondary electron detection control system which can set up the conte lath and luminosity of a secondary electron image for every beam by independent illuminating system, It is possible to interlock the SIM image at the time of cross section processing and the SEM image of section observation with a beam change in real time, and to display on an image display device vividly.

[Example]

Drawing 1 is a schematic diagram showing the composition of one example of this

invention. A gallium liquid metal ion source is used for the ion source 31, and a place is scanned for the ion beam 1 which accelerated and converged by the ion optics system 3 arbitrarily on the sample 2 by the XY deflecting electrode 38, the beam blanking electrode 40, and the sample stage 4. The secondary electron 5 emitted from the sample 2 is detected with the secondary electron detector 6, and a secondary electron image is displayed on CRT20 for observation. The above is the composition of a scanning ion microscope (SIM). The electron beam 11 generated from the electron source 10 accelerates and converges by the electron optics system 41, and scans the sample 2 top with the XY deflection coil 16. The secondary electron 5 emitted from the sample 2 by the exposure of the electron beam 11 is detected with the secondary electron detector 6, and a secondary electron image is displayed on observation CRT20. The above is composition at a scanning electron microscope (SEM).

Since distinction is not attached, when displaying a secondary electron image on CRT for observation, using the beam change machine 17, the secondary electron 5 by ion beam excitation and the secondary electron 5 by electron beam excitation perform a change with an ion irradiation system and an electron irradiation system, and switch a SIM image and a SEM image. And in order to amend the difference of the amount of secondary electrons of ion beam excitation, and the amount of secondary electrons of electron beam excitation and to make legible the contrast and the luminosity of a SIM image and a SEM image almost equally, In front of the main amplifier 7, it has independently the preamplifier 18 for SIM, and 19 for SEM, you make it the beam change machine 17 interlocked with — the high voltage power supply of the image intensifier (not shown) in the secondary electron detector 6 — the object for SIM, and the object for SEM — a change with a clear and legible SIM image and SEM image is performed by making it separate and making it the beam change machine 17 interlocked with. The SIM image display area 21 and the SEM image display area 22 are established in CRT20 for a display of the computer for control, and each image is displayed as a stillness image. Drawing 2 explains the example of section observation of the wiring 27 of the contact hole part 23. Introduction and the field 40 including section Intelligence Department which shows the dashed line of Drawing 2 are simultaneously sprayed in the material gas (usually tungsten carbonyl) from an exposure and the tear gas gun 8 of the focused ion beam 1, and metal membrane attachment is performed to the field 40. Next, ditch excavation processing of the processing area 26 enclosed with the dashed dotted line of Drawing 2 is carried out by the sputter etching by ion beam irradiation, the section of the contact hole part 23 is exposed, then, this is switched to the electron beam exposure from an oblique direction, and the cross section image of Drawing 3 is acquired. That is, the metal membrane section 47 formed by the insulator layer section 48 and the wiring sections 41 and 42 on the substrate 46, the protective film section 45, and this method is observed. The contact part 23 of the wiring 41 and

the wiring 42 is observed. In this case, in this invention device, an ion beam irradiation system and an electron beam irradiation system are independent. Since the photo-multiplier high voltage of the secondary electron detector 6 the object for SIM images and for SEM images and the preamplifiers 18 and 19 of a secondary electron signal are also switched by linkage at the same time an ion beam and an electron beam are switched with the beam change machine 17. The contrast and the luminosity of a SIM image and a SEM image can be adjusted legible, respectively. And if needed in processing operation, an ion beam and an electron beam are switched to real time with a beam change machine, and a clear SIM image and SEM image are displayed, respectively. By this composition, the cross section processing of a place made into the purpose and observation of sectional shape can be switched continuously.

[Effect of the Invention]

In this invention, an ion beam and an electron beam are switched for the cross section image of the place of the purpose of a semiconductor sample to real time if needed in processing operation by the above-mentioned composition, and a clear image can be displayed.

Therefore, it has the effect that a minute foreign matter and disordered shape can be discovered promptly.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

They are a figure in which Drawing 1 shows the composition of one example of this invention, and a figure in which Drawing 2 shows the plan of the contact hole part of

LSI, and Drawing 3 shows the sectional view in the 3rd figure.

- 1 Focused ion beam
- 2 Sample
- 3 Ion optics system
- 4 Sample stage
- 5 Secondary electron
- 6 Secondary electron detection
- 7 Main amplifier
- 8 Organometallic compound gas gun
- 9 Beam blanking electrode
- 10 Electron source
- 11 Electron beam
- 12 condensing lens (electromagnetism type)
- 13 Beam blanking coil
- 14 Sting meter coil
- 15 Object lens (electromagnetism type)
- 16 XY change coil
- 17 Beam change machine
- 18 Preamplifier for SIM
- 19 Preamplifier for SEM
- 20 CRT for a display
- 21 SIM increase display area
- 22 SEM increase display area
- 23 Contact hole part
- 26 Processing area

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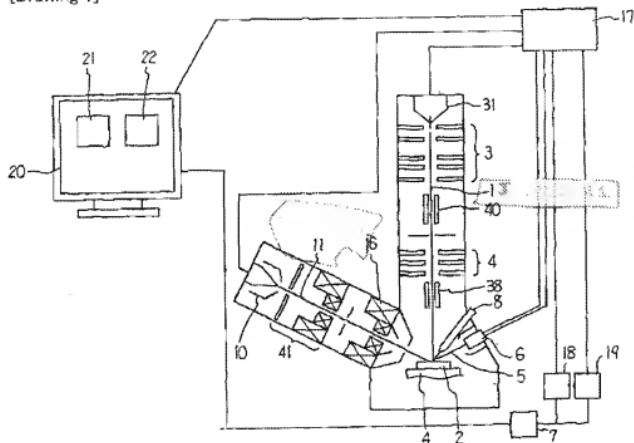
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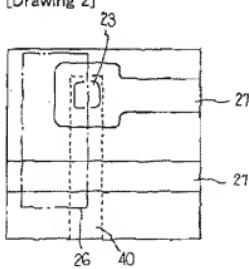
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DRAWINGS

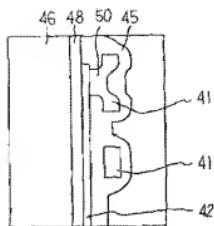
[Drawing 1]



[Drawing 2]



[Drawing 3]



[Translation done.]